ORIGINAL

Before the
Federal Communications Commission
Washington, D.C. 20554

In the Matter of	)	
	)	
The Establishment of Policies and	)	
Service Rules for the Non-Geostationary	)	IB Docket No. 02-19
Satellite Orbit, Fixed Satellite Service	)	
in the Ka Band	)	

COMMENTS OF TELEDESIC LLC

Mark A. Grannis
Kelly S. McGinn
Harris, Wiltshire & Grannis LLP
1200 Eighteenth Street, N.W.
Washington, D.C. 20036
(202) 730-1300

Counsel for Teledesic LLC

April 3, 2002

SUMMARY

As the first and only currently-licensed NGSO FSS system in the Ka-band, Teledesic strongly believes that the third sharing option outlined by the Commission in the NRPM, "Avoidance of In-Line Interference Events," offers the most efficient and effective method for promoting sharing among multiple Ka-band NGSO FSS operators without unduly constraining the operators' flexibility to use the band as intensively as possible. Teledesic looks forward to bringing its NGSO FSS system into use in September 2004 and entering continuous commercial service in 2005. Furthermore, Teledesic is ready to cooperate with subsequent licensees as they seek mutually satisfactory coordination agreements from Teledesic and place their own Ka-band NGSO FSS systems into service.

Of the sharing options proposed by the Commission in the NPRM, Option III – "Avoidance of In-Line Interference Events" – is the only option that actually accommodates the Commission's policy objectives. In particular, Option III maximizes the access of NGSO FSS systems to available spectrum while ensuring that harmful interference is avoided. It promotes spectrum coordination, allows the most flexibility for adapting to different licensing regimes, and most effectively prevents spectrum warehousing. It also promotes equitable burden sharing among second-round licensees. Although there are elements of the Commission's description of Option III that raise concerns about the extent to which the Commission will respect settled expectations in the satellite industry, these concerns could be easily addressed in the implementation of Option III.

As explained in the comments, Teledesic believes that the other three sharing options proposed by the Commission are seriously flawed. Option I is spectrum-inefficient as a default outcome and of little value as a starting point for coordination discussions, even if it is only

applied to second-round applicants. If Option I were applied retroactively to Teledesic, as a footnote in the NPRM suggests, it would be even worse – less efficient, less practical, and less equitable as well.

Option II shares many of the flaws identified above for Option I. Moreover, because Option II applies to "operational systems," it appears that it would apply not just to second-round applicants, but to Teledesic as well. However, Option II fails to explain how the coordination process would work if Teledesic were covered by Option II; indeed, the Commission's description of Option II jumps so quickly to the "default" outcome of band segmentation that it could be read to suggest that no party is obligated even to attempt to reach a coordinated solution. If this is indeed what the Commission intends, then Option II would be inconsistent with the normal rules of coordination priority. For these reasons, Option II is unsatisfactory either as a default outcome or as a starting point for coordination discussions, and the Commission should reject it.

Option IV, "Homogeneous Constellations," is presented in the NPRM not so much as a concrete sharing option but rather as a concept that might be elaborated further to yield a sharing solution. One can confidently say, however, that Option IV is inferior to Option III in virtually all respects.

Teledesic is confident that the Avoidance of In-Line Events sharing model can be implemented equitably without creating any additional burdens for NGSO FSS operators. To this end Teledesic provides suggestions in Section II of its comments in response to the technical issues raised by the Commission regarding the implementation of Option III. In addition to this technical analysis, Teledesic addresses a non-technical, purely regulatory issue

related to implementation of Option III – the need to make it consistent with current law and practice regarding licensing and coordination.

Finally, Teledesic comments on a few miscellaneous questions posed in the NPRM about such issues as financial qualifications, milestones, and reporting obligations. In general, Teledesic urges the Commission to regulate second-round licensees in continuity with the service rules promulgated for first-round licensees. While there are ample reasons for thinking these rules can be improved, those matters are more appropriately considered in the Commission's pending rulemaking on satellite licensing reform.

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COMMENTS OF TELEDESIC LLC

Teledesic is pleased to submit these Comments in response to the Commission's Notice of Proposed Rulemaking ("NPRM") in the above-captioned proceeding.[1] As the first and only currently-licensed NGSO FSS system in the Ka-band, Teledesic strongly believes that the third sharing option outlined by the Commission in the NRPM, "Avoidance of In-Line Interference Events," offers the most efficient and effective method for promoting sharing among multiple Ka-band NGSO FSS operators without unduly constraining the operators' flexibility to use the band as intensively as possible. Teledesic looks forward to bringing its NGSO FSS system into use in September 2004 and entering continuous commercial service in 2005. Furthermore, Teledesic is ready to cooperate with subsequent licensees as they seek mutually satisfactory coordination agreements from Teledesic and place their own Ka-band NGSO FSS systems into service.

In Part I of these comments, Teledesic explains why Option III, the "Avoidance of In-Line Interference Events" model, is the only option that actually accommodates the Commission's principal policy objectives. Part II sets forth a detailed discussion of the way in

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[1] Notice of Proposed Rulemaking, FCC 02-30, 2002 F.C.C. LEXIS 588, I.B. Docket No. 02-19, (rel. Feb. 6, 2002).

which Option III can be integrated into the existing regime of coordination among licensees (which the Commission has recently reaffirmed), and addresses the Commission's specific technical questions about the implementation of Option III. Part III addresses the Commission's proposed service rules, recommending in general that the Commission regulate second-round Ka-band NGSO FSS licensees in accordance with existing policies and defer any substantial changes in the service rules to the pending rulemaking proceeding on reform of the satellite licensing process.

I. ADOPTION OF AN AVOIDANCE OF IN-LINE EVENTS MODEL WILL PROMOTE EQUITABLE, FLEXIBLE, EFFICIENT, AND COOPERATIVE USE OF KA-BAND SPECTRUM BY NGSO FSS SYSTEMS

Although it is entirely reasonable that the Commission would propose several options for consideration, there is no question that an Avoidance of In-Line Interference Events sharing technique will most successfully fulfill the principal objectives identified by the Commission. Before examining each of the four sharing options, it is useful to review these policy objectives.

First and foremost, the Commission is seeking to develop a sharing model that equitably allocates the sharing burden among NGSO FSS systems with different system designs and different coordination priorities.[2] The equity of the sharing arrangement is evaluated in two distinct dimensions: (a) technological neutrality, such that regulatory fiat does not replace the market as the primary determinant of "the most effective implementation of the NGSO FSS systems"[3]; and (b) equity among second-round licensees, both with respect to each other and with respect to Teledesic, with whom they must all coordinate.[4]

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2 *Id.* at ¶¶ 13-14.

3 *Id.* at ¶ 13.

4 *Id.* at ¶ 14.

Second, the Commission aims to adopt a sharing plan that "prevent[s] spectrum warehousing by non-implemented NGSO FSS systems at the expense of operating systems."[5] Anticipating that some of the second-round systems may not be implemented, the Commission rightly hopes to "maximize spectrum availability to operational systems, while incorporating sufficient flexibility to accommodate all applicants once they commence operations."[6]

Third, the Commission hopes to make the most of a very limited amount of NGSO FSS spectrum by encouraging cooperative spectrum sharing among NGSO FSS operators.[7] Obviously, coordinated spectrum sharing is always *possible,* no matter which option is chosen. Consequently, evaluation of the four sharing options with respect to this policy objective necessarily requires the commenters and the Commission to imagine the incentives that face each operator in a variety of situations. The task is to assess not what *could* happen, but what would be *likely* to happen, given all the incentives in place.

Fourth, the Commission seeks to provide operational systems with the greatest flexibility to tailor their operations to various spectrum requirements over which the FCC has no control. These include the licensing regimes and spectrum planning decisions of foreign administrations,[8] as well as "garden variety" ITU coordination.

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5 *Id.* at ¶ 15.

6 *Id.* at ¶ 15.

7 *Id.* at ¶ 16.

8 In ¶ 17 of the NPRM, the Commission makes reference to Decisions of the European Radiocommunications Committee (now European Electronics Committee – ECC) with respect to the use of the bands 17.7-19.7 GHz and 27.5-29.5 GHz, and speculates that "they may have a significant impact on the commercial viability of the proposed NGSO FSS systems". These ERC decisions potentially constrain widespread deployment of FSS Earth stations within certain European countries, and demonstrate why the flexibility of having access to the full 2 x 500 MHz of spectrum under consideration (Option III) is so important. However, that is indeed the only connection between the ERC decisions and the matter of sharing among NGSO FSS systems. As unfortunate and mistaken as the ERC decisions are, Teledesic is of the view that these decisions will not threaten the overall commercial viability of NGSO FSS systems, as NGSO FSS systems can target the many areas in Europe where conditions are more favorable, including countries with only limited FS deployment

Three of the four sharing options are by nature "default" options that are to take place in the absence of a coordination agreement to the contrary. The consequences of this are two-fold. First, in evaluating Options I, II, and III, it is necessary to evaluate the merits of the default arrangement both as a final outcome (*i.e.*, assuming coordination is unsuccessful) and as a starting point for further negotiations. Second, no matter which option the Commission selects, it is important that the Commission do nothing to disrupt the already-established rules according to which each licensee is required to seek coordination from each previous licensee.[9]

Of the sharing options proposed by the Commission in the NPRM, Option III – "Avoidance of In-Line Interference Events" – best promotes the Commission's policy objectives. In particular, Option III maximizes the access of NGSO FSS systems to available spectrum while ensuring that harmful interference is avoided. It promotes spectrum coordination, allows the most flexibility for adapting to different licensing regimes, and most effectively prevents spectrum warehousing. It also promotes equitable burden sharing among second-round licensees. Although there are elements of the Commission's description of Option III that raise concerns about the extent to which the Commission will respect settled expectations in the satellite industry, these concerns could be easily addressed in the implementation of Option III. In the sections that follow, Teledesic analyzes all four proposals in detail.

Continued . . .

and countries that, recognizing the potential benefits of NGSO FSS systems, may have chosen to implement national regulatory regimes which are more favorable to satellite systems.

[9] *Teledesic Corporation Petition for Clarification And/Or Reconsideration*, Memorandum Opinion and Order, FCC 02-6, 2002 FCC LEXIS 589, CC Docket No. 92-297, (rel. Feb. 6, 2002) (hereinafter *"Teledesic Clarification Order"*).

A. Option I – Flexible Band Segmentation

In its purest form, Flexible Band Segmentation involves dividing the total amount of spectrum by *n*, where *n* is the number of qualified applicants in a given processing round. Assuming that all five applicants in the second Ka-band NGSO FSS processing round are found to be qualified, this would mean that each second-round applicant would have "priority use" over each other second-round applicant in 2 x 100 MHz of the 2 x 500 MHz that is available. All of the second-round applicants would be licensed subject to coordinating their spectrum use with Teledesic.

This pure form of Option I equitably allocates the burden among second-round licensees, and also achieves an equitable allocation of the burden *vis-à-vis* Teledesic, since Teledesic would retain its existing coordination priority. Moreover, Option I successfully avoids any unintended tipping of the scales toward one particular technology or system design – the marketplace will be allowed to pick a winner.

However, Option I is decidedly inferior to Option III in virtually every other way. The biggest deficiency of Option I is its built-in spectrum-inefficiency: Option I "over-mitigates." That is, in the absence of a coordination agreement, Option I calls for each of the second-round systems to implement some form of band segmentation 100% of the time, when in reality band segmentation is only required (at most) during in-line interference events. Hence, as a default outcome, Option I is extremely inefficient.

Option I is also inferior as a starting point for negotiations toward encouraging coordinated spectrum sharing, because the $1/n^{th}$ of the 2 x 500 MHz in which each system would have priority may not correspond to the way spectrum is actually used in any particular system. For example, @contact may have priority in the lowest 2 x 100 MHz and Hughes may

have priority in the second-lowest 2 x 100 MHz. If both systems are designed to use 250 MHz carriers, then Option I dictates a default spectrum priority that is completely unhelpful. In such a case, the two systems would be required to coordinate their use of the spectrum essentially "from scratch" – thus becoming much more like Option III – except that the pre-existing and conflicting "default" rights would complicate the negotiations.

Option I is also inferior in terms of facilitating the flexibility that is necessary in order to comply with non-U.S. spectrum requirements. All NGSO FSS systems need maximum flexibility to accommodate locally varying band plans and licensing regimes. Consequently, all systems must have the agility to operate over the full 2 x 500 MHz under consideration. Obviously, Option I does not *prevent* this, and it may happen if coordination among the systems is successful, but in that case the success would be due to a coordination process of the type contemplated by Option III; Option I provides no help in this regard.

In a footnote, the Commission also raises the possibility that Option I could be applied not just prospectively (*i.e.*, applied to the second-round applicants), but retroactively to Teledesic as well.[10] Although the Commission's description of Option I does not clearly distinguish between coordination priority on the one hand and "priority use" or "right of selection" on the other, this potential variation on the pure form of Option I would appear to undermine the normal rules of coordination priority – rules of priority that were specifically reaffirmed in this very band in an order released the same day as the NPRM in this proceeding.[11] This variation on Option I would fail to achieve an equitable allocation of the sharing burden between the second-rounders and Teledesic, because it would seem to give any

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[10] NPRM at n.39.

[11] *See Teledesic Clarification Order*, 2002 FCC LEXIS 589 at ¶ 9.

second-round licensee an absolute right to evict Teledesic from a substantial portion[12] of the spectrum it is already licensed to use. It is inappropriate for the Commission to give a private competitor the legal right to reduce Teledesic's spectrum. Teledesic is confident that it will be able to reach mutually satisfactory coordination agreements with any second-round licensees who later bring their systems into use, and Teledesic certainly prefers a coordinated outcome to full-time band segmentation. However, it is conceivable that a future licensee may value coordinated sharing less highly, and Teledesic's use of its assigned spectrum should not be effectively subject to obtaining a subsequent licensee's consent. Thus, Teledesic objects in principle to any sharing model that gives private competitors the right to effect a full-time reduction in the bandwidth over which Teledesic may operate.[13]

In summary, even the "pure" version of Option I is spectrum-inefficient as a default outcome and of little value as a starting point for coordination discussions. Applying this approach retroactively to Teledesic would make it even worse – less efficient, less practical, and less equitable as well.

B. Option II – Dynamic Band Segmentation

Option II, Dynamic Band Segmentation, is similar to Flexible Band Segmentation except that instead of segmenting the band into as many pieces as there are *applicants*, it segments the band into as many pieces as there are *operational systems*. Not surprisingly, Option II shares many of the flaws identified above for Option I. Moreover, because Option II applies to

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[12] The portion would apparently no longer be 2 x 100 MHz, but rather 2 x 83.667 MHz. This raises an additional practical problem with this version of Option I, which is that it is very unlikely that any licensee could make efficient use of a Selected Spectrum Assignment of only 83.667 MHz in each direction.

[13] In addition, retroactive application of such a draconian default outcome to Teledesic now would send a message to investors that the rules are liable to be changed retroactively at any time. At a time of total capital starvation for the satellite industry, this is the last thing the Commission should do.

"operational systems," it appears that it would apply not just to second-round applicants, but to Teledesic as well. However, Option II fails to explain how the coordination process would work if Teledesic were covered by Option II; indeed, the Commission's description of Option II jumps so quickly to the "default" outcome of band segmentation that it could be read to suggest that no party is obligated even to attempt to reach a coordinated solution. If this is indeed what the Commission intends, then Option II would be inconsistent with the normal rules of coordination priority.[14] For these reasons, Option II is unsatisfactory either as a default outcome or as a starting point for coordination discussions, and the Commission should reject it.

Like Option I, Option II successfully avoids any unintended tipping of the scales toward one particular technology or system design. Furthermore, to the extent that Option II applies to second-round applicants, it also achieves an equitable allocation of the sharing burden *among those applicants*. The second-round applicants filed their applications at or about the same time, based on the same Commission public notice. Under the processing round system that has long been in effect, these applicants would have expected to have essentially equal rights *vis-à-vis* each other and an obligation to coordinate with Teledesic, all of which is fair. As it applies to second-round applicants, Option II honors this basic equality among second-rounders but adds what is essentially a "tiebreaker" for resolving the practical effect of these equal priorities. Under Option II, even though two second-round systems are filed on the same day and granted on the same day, with exactly equal rights, one of the systems can obtain "priority in selecting

[14] *Cf.* NPRM at ¶ 14; *Teledesic Clarification Order*, 2002 FCC LEXIS 589 at ¶ 9. As explained in Part II.A with respect to Option III, it would be possible to implement Option II in such a way as to leave coordination priority (as opposed to substantive division of the spectrum) undisturbed.

spectrum segments" in the order in which they become operational.[15] Presumably, this "priority use" or "right of selection" would apply only if there is no coordination agreement, but the Commission does not explicitly address the way in which coordination would be conducted. Indeed, the Commission refers to coordination only in passing, stating obliquely that "[n]othing would prevent systems that find ways to share from pooling their spectrum segments."[16] Operators are to "notify the Commission" of their spectrum selections, possibly without any obligation to coordinate with each other at all.

If in fact Option II makes coordination entirely optional, then it is completely unacceptable, for it fails to advance the Commission's articulated goal of encouraging cooperative spectrum sharing among NGSO FSS operators.[17] Because co-frequency sharing is possible for the vast majority of the time (*i.e.*, at all times except during in-line interference events), band segmentation must be regarded as a last resort and coordination must be encouraged.[18] Yet Option II includes no clear requirement that any operator even attempt to coordinate with any other. Furthermore, even if the Commission's intent was that coordination would still be required under Option II, the failure of Option II even to address the procedure for effecting coordination (i.e., who has to seek coordination from whom) is a glaring and disqualifying defect. Once it becomes operational, Teledesic would seem to be covered by Option II, so the absence of any obvious coordination obligation would be a fairly

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[15] NPRM at ¶ 23.

[16] *Id.* at ¶ 24.

[17] *Id.* at ¶ 16.

[18] This is one of the two most fundamental differences between the NGSO portion of the Ka band and some of the other bands in which the Commission has proposed sharing options similar to those in the NPRM. In the 2 GHz MSS band, for example, co-frequency sharing was obviously impossible, so band segmentation was essentially the only feasible option for multiple entry. By contrast, the feasibility of co-frequency sharing among NGSO FSS systems (except during in-line events) has been exhaustively studied and confirmed. At bottom, this is what makes full-time band segmentation so inappropriate for this proceeding.

sharp departure from settled law. As a starting point for coordination discussions, Option II is an abject failure.

In addition, even considered purely as a "default" outcome, Option II shares the worst deficiencies of Option I. The first of these is its built-in spectrum-inefficiency. Like Option I, Option II establishes a ("default"?) sharing regime according to which each operational system must implement band segmentation 100% of the time, when in reality band segmentation is only required (at most) during in-line events. Again, as with Option I, the individual licensees could certainly agree on an alternative plan for mitigation of interference, but insofar as they did so they would be implementing Option III, not Option II. Second, Option II fails to achieve an equitable allocation of the sharing burden as between the second-rounders and Teledesic, in much the same way that the retroactive version of Option I would. As it currently stands, Option II appears to allow a second-round system to become operational at a time when Teledesic is already using the full 2 x 500 MHz and simply "notify the Commission" which half of the band it would like to use. Even if the omission of any obligation to coordinate was just an oversight in the NPRM, it is inappropriate for the Commission to give a private competitor the legal right to cut Teledesic's spectrum in half.

Option II also shares other, less serious defects of Option I. For example, Option II carries with it the risk that at any given time the band may be divided into halves, then thirds, then fourths, etc. As a practical matter, it would be prohibitively difficult to build satellites that could efficiently use bandwidths of 250 MHz for a few months, then 167.67 MHz, and then 125 MHz, etc. Like Option I, then, Option II yields a coordination result that is unhelpful as a method of promoting sharing in practice. And also like Option I, Option II would tend to

complicate all licensees' participation in licensing activities outside the U.S., as well as ITU coordination.

In summary, Option II contains serious flaws that make it an ineffective option for achieving the Commission's principle policy objectives. Fortunately, many of these flaws are corrected by Option III.

C. Option III – Avoidance of In-Line Interference Events

Option III, Avoidance of In-Line Interference Events, is by far the most spectrum-efficient of the sharing options described in the NPRM. Under Option III, every licensed NGSO FSS systems would be *authorized* to use the entire 2 x 500 MHz of NGSO FSS spectrum *all* of the time, and would be *able* to use the entire 2 x 500 MHz the vast majority of the time at every service location. Only to address in-line events would operators have to coordinate and agree on interference mitigation measures. As the Commission recognizes, Option III "requires sub-dividing the NGSO FSS spectrum only during the time intervals involved in potential in-line interference events and only if coordination and satellite diversity cannot be implemented."[19]

The primary advantage of Option III is its spectrum efficiency. For NGSO FSS networks, any curtailment in the ability to make use of assigned spectrum is a direct reduction in the amount of traffic the system can carry. Limitations on access to portions of the band should therefore be the *last* resort as a sharing solution, not the first. In-line events between any two systems occur during a very small percentage of the time. Coordination by the affected operators to resolve these comparatively infrequent events is obviously preferable to any arrangement that requires band segmentation as the default arrangement 100% of the time. For this reason alone, Options I and II are unambiguously inferior to Option III.

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[19] NPRM at ¶ 32.

Option III also does an excellent job of preventing any spectrum from being wasted on systems that are never brought into use, because the only reason spectrum is *ever* unavailable to *any* system is due to an in-line event – and non-existent systems do not cause in-line events. Furthermore, by ensuring that all systems will be permitted to operate across the entire 2 x 500 MHz for nearly all of the time, Option III will provide U.S. licensees with the flexibility they need in order to maximize their ability to deal with inconsistent foreign licensing regimes and the demands of ITU coordination.

However, while Option III is generally excellent at *minimizing* the burden of sharing, it is less than ideal in the way that it *allocates* that burden. Specifically, the Commission's description of Option III appears to make the date on which the first satellite is launched the new criterion for coordination priority.[20] This essentially takes a criterion that would be an excellent tiebreaker between systems in the same round, and turns it into a new system of priority, which differs both from the domestic rules under which Teledesic was licensed and from the pre-existing international coordination rules to which both Teledesic and the second-round systems are subject.

Option III need not be implemented in this objectionable fashion. The essence of Option III is coordination to deal with in-line events. To that extent, Option III could easily be treated merely as a subset of the coordination regime already in place. All second-round licensees are obligated to seek coordination with Teledesic, which is in turn obligated to coordinate with the second-round licensees in good faith. There is no obvious reason why Option III requires any departure from this well-established system, even in the unlikely event that a second-round licensee launches its first satellite before Teledesic does. The suggested

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[20] "Prior to the launch of its first satellite, each NGSO FSS operator would be required to complete coordination with all other operational NGSO FSS systems." *Id.* at ¶ 28.

"first-to-launch" criterion would be retained, but it would only function as a way of assigning definite coordination priorities to the second-rounders who currently have no coordination priority *vis-à-vis* each other. This subject is explored in greater detail in Part II.A, *infra.*

D. Option IV – Homogeneous Constellations

Option IV, "Homogeneous Constellations," is presented in the NPRM not so much as a concrete sharing option but rather as a concept that might be elaborated further to yield a sharing solution. Option IV builds on the long-established fact that if two or more systems coordinate their constellation parameters closely enough, they can share the spectrum without the need for band segmentation or special avoidance measures. The Commission suggests variously that it could (a) adopt one standard constellation design to which all licensees would need to adhere; (b) adopt two or more standard constellation designs and let operators choose, with the band divided equally between the designs; or (c) adopt one standard constellation but give it access to less than the full bandwidth so that licensees wishing to adopt a different technical approach are not shut out of the band. These sub-options differ substantially enough that it is difficult to evaluate Option IV without knowing exactly how it would be implemented. One can confidently say, however, that Option IV is inferior to Option III in virtually all respects.

First, Option IV does not guarantee, and may not bring about, an equitable distribution of the sharing burden. Under any version of Option IV, the Commission would obviously be favoring one or more technical approaches and disfavoring others. This is contrary to the goal of promoting a market-based determination of the most effective implementation strategy. In addition, there are any number of subsidiary choices that would have to be made in the implementation of this option that might justly be described as inequitable to one or more

system proponents. These include not only the definition of the "standard" constellation(s) but decisions about how much spectrum should be dedicated to "standard" versus non-standard constellations.

Option IV could also be extremely inefficient with respect to capacity that remains unused when systems are not timely implemented. For instance, if two standard constellations were identified but only one of the standards was actually adopted by a deployed network, half of the total capacity in the band might remain unused. Systems following the implemented standard would presumably have been designed to use only their half of the spectrum, and might find it impossible or uneconomical to make the changes necessary to make use of the other spectrum. Moreover, while Option IV would be very effective at promoting shared use of the spectrum by all of the systems adopting a standard constellation design, it would do almost nothing to promote coordination between those systems and Teledesic. And Option IV would probably give U.S. NGSO FSS licensees the least imaginable flexibility with respect to foreign administrations and the satellite systems they sponsor at the ITU.

In summary, Option III is fairer and more spectrum-efficient than Options I, II, or IV, and will leave operators with much more flexibility with respect to licensing in other countries and international coordination. The in-line events model of Option III leaves all operators free to use all frequencies for as much of the time as possible, requiring coordination and mitigation measures only during in-line events.

II. THE AVOIDANCE OF IN-LINE EVENTS SHARING MODEL CAN BE IMPLEMENTED EQUITABLY, WITHOUT CREATING ANY ADDITIONAL BURDENS FOR NGSO FSS OPERATORS

In the NPRM, the Commission raises several specific points pertaining to the implementation of Option III, and solicits comments on each. These include: (a) "how

frequently . . . orbital elements need to be updated"[21]; (b) the adequacy of the in-line event definition and "whether there is a need for additional provisions to address NGSO FSS systems using adaptive coding"[22]; (c) "whether there is a need to scale the aggregate interference allowance (10%) ... to account for multiple interference sources"[23]; and (d) the "impact [of Option III] on system designs and commercial feasibility."[24] Teledesic is pleased to address each of these technical matters in this Part of the comments. However, Teledesic first addresses a non-technical, purely regulatory issue related to the implementation of Option III – the need to make it consistent with current law and practice regarding licensing and coordination.

A. The "First to Launch" Aspect of Option III Should Not Displace Teledesic's Coordination Priority

The issue of coordination between second-round licensees and Teledesic is addressed in several portions of the Commission's NPRM, and implicated in several more. As noted above in connection with several of the proposed sharing options, the options with "first to launch" elements (Options I, II and III) carry with them the danger that the Commission will adopt a sharing approach for this band that cannot be reconciled with the Commission's broader licensing policies. In this section, Teledesic explains the ways in which a "first to launch" regime such as Option III may conflict with pre-existing rules, and suggests a modification to Option III that would avoid this difficulty.

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[21] NPRM at ¶ 27.

[22] *Id.* at ¶ 30.

[23] *Id.* at ¶ 31.

[24] *Id.* at ¶ 32.

The pre-existing rules on coordination between systems licensed in different rounds have been clarified very recently,[25] in an order the Commission aptly summarizes in the background section of the NPRM: "[S]econd round licensees' access to spectrum is subject to coordination with Teledesic," and "Teledesic must also coordinate with second round NGSO systems in good faith."[26]

As to the substance of the coordination(s), the Commission makes clear that "the farther along a licensee is in the construction of its system, the less flexibility it has to redesign its system to accommodate new entrants."[27] This is essentially the same understanding that has always governed internationally for satellite coordinations among systems with different ITU priorities – a clearly defined hierarchy of coordination priorities, combined with intentionally vague guidance about what the substantive outcome of a given coordination should be. The distinction between coordination priority and the substantive outcome of the coordination is critical. To say that System A has coordination priority over System B is to say merely that it is System B's duty to request coordination from System A and successfully conclude an agreement prior to bringing its network into use. It is *not* to say that all potential spectrum conflicts are to be resolved in favor of System A, or that System A need do nothing in order to make it possible for System B to operate.

Because FCC licensees have always been required to coordinate with previous licensees to whom they might otherwise cause harmful interference, the ITU environment provides a fairly close analogy to the situation created by successive processing rounds. However, within a single processing round, there has rarely if ever been anything to coordinate because

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[25] *Teledesic Clarification Order*, 2002 FCC LEXIS 589.

[26] NPRM at ¶ 14.

[27] *Id.* at ¶ 14.

interference issues have generally been resolved during the licensing process. Consequently, current FCC licensing practice does not assign a unique coordination priority to systems within the same processing round. Applications within a single round are typically filed on the same day, cut off on the same day, and granted on the same day, which makes all of these licensees basically equal to each other in priority – and subordinate to any previous licensees.

The source of the difficulty with the "first to launch" elements of the Commission's proposals is that the Commission seems to contemplate using the "first to launch" criterion not just as a "tiebreaker" for systems licensed in the same processing round, but rather as a substantive reshuffling of the deck that applies even to previously licensed systems such as Teledesic. To the extent that the Commission uses a "first to launch" criterion to assign a coordination priority where none previously existed, it tends to increase regulatory certainty and make it easier for the parties to reach negotiated settlements that are in the public interest. However, to the extent that the Commission uses a "first to launch" criterion to assign a redundant coordination priority where one already existed, as in the case of satellite systems licensed in different processing rounds, it would seem to be setting up a third ranking of coordination priorities, a ranking which is difficult to reconcile either with the ITU model or the pre-existing FCC model. This can only create regulatory confusion, and possibly even impasse, in situations where the rankings dictated by the various regimes yield different results.

Teledesic agrees that having the first satellite of the constellation in its intended orbit and transmitting and receiving on the licensed frequencies is a significant event. Furthermore, the Commission's proposal to define how coordination should be conducted within Option III is reasonable for systems within the same processing round. However, for systems in different processing rounds, to rely on the launching of the first satellite to define whom each operator

would have to seek coordination from, would erode the regulatory certainty that should be associated with the granting of a license by the Commission.

Accordingly, Teledesic urges the Commission to modify Option III so as to bring the "first to launch" criterion into line with existing law, which assigns different coordination priorities to systems licensed in different rounds. Under this construction of Option III, the first second-round system to launch a satellite into its intended orbit would gain coordination priority over subsequently launched second-round systems, but not over Teledesic. This would not, however, make it unnecessary for Teledesic to show flexibility in accommodating second-round applicants. Teledesic certainly understands that coordination is a two-way process in which the operator from whom coordination is being sought is expected to take measures to accommodate the other operator. At the same time, there is a need to establish clearly who has to obtain a coordination agreement from whom. The Commission's recent statements about NGSO FSS coordination in the Ka band have articulated these principles with the requisite clarity, and the Commission must ensure that its adoption of a sharing approach for the second round does not obfuscate that clarity.

B. Exchange and Update of Orbital Elements

The Commission notes that in order to avoid in-line interference events successfully, operators will be required to exchange ephemeris data for each affected NGSO FSS system.[28] In principle, Teledesic agrees that periodic disclosure of orbital elements in the NORAD 2-line element format will be an appropriate way to effect exchange of ephemeris data.

While standardizing ephemeris exchange formats and prediction models is highly desirable, it should be recognized that in order to achieve improved accuracy and longer

[28] NPRM at ¶ 27.

prediction time frames operators may wish to use special perturbation models instead. These models might then require exchange of additional information. Teledesic proposes therefore that exchange of data in the NORAD 2-line element format be taken as the default standard without preventing any two operators from using better-performance models, if they so agree.

In response to the specific question on how frequently these orbital elements need to be updated, Teledesic conducted a brief analysis to compare the position error obtained with propagated NORAD 2-line element (TLE). The comparison was done for an active MEO satellite where the actual satellite state vectors were known. The NORAD TLE set closest in time to the state vector epoch was propagated forward and then the position error was computed.

It has been concluded that the in-track error is the dominant error component – with a maximum observed error of roughly ±15 km. At the considered orbit altitude, this corresponds to approximately ±3 seconds in prediction error and maximum topocentric angle error of ±0.09°. The maximum observed radial and cross-track errors are both around ±5 km. The conclusion is that the NORAD TLE and accompanying propagation model appear to do an adequate job of predicting satellite position information.

Most TLE sets used in the analysis were reported on a daily basis, although gaps as large as six days were also present. It has been observed that when predicting over a one-day to a six-day period, the growth in error is very slight. Accordingly, Teledesic tentatively concludes that for MEO satellites weekly reporting may be sufficient (in the absence of any significant orbit adjust maneuvers). Further studies should be conducted to confirm this tentative conclusion

for MEO satellites and, more importantly, to determine what reporting frequency should be used in connection with LEO and HEO satellites.[29]

C. In-Line Event Definition

The NPRM notes that Teledesic's comments on the Ku-band NPRM proposed "that a 10% aggregate allowance applicable to the interference from NGSO FSS systems be adopted as the in-line event coordination threshold."[30] The Commission rightly notes that the Ku- and Ka-band system characteristics are similar and therefore the same definition can be applied in connection with Ka-band sharing. Teledesic certainly supports this proposal, for the reasons stated in its Ku-band comments.[31]

The Commission further inquires "whether there is a need for additional provisions to address NGSO FSS systems using adaptive coding."[32] Teledesic notes that '*recommends*' 3.3 of Recommendation ITU-R S.1323-1 addresses the case of systems using adaptive coding. Instead of limiting aggregate interference to the level corresponding to "10% of the time allowance for the BER (or C/N value) specified in the short-term performance objectives" (as prescribed in '*recommends*' 3.1), '*recommends*' 3.3 limits aggregate interference to the level corresponding to "a 10% decrease in the amount of reserve capacity available to links that require heavier coding to compensate for rain fading."

Therefore, the definition of in-line interference event proposed by the Commission in

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[29] With respect to highly elliptical orbits, the Commission states, "If future applicants employed highly elliptical orbits, in-line interference events could be avoided using mechanisms that do not rely on ephemeris data." NPRM at ¶ 27. Teledesic disagrees with this statement because a HEO satellite does not remain stationary relative to the Earth within its active arc or window. Therefore, ephemeris data could be used to protect only the active HEO satellite, significantly reducing the impact of unnecessary mitigation that would result from protecting portions of a HEO arc or window where no satellite is currently located.

[30] NPRM at ¶ 30.

[31] Comments of Teledesic LLC at 5, I.B. Docket No. 01-96, filed July 5, 2001.

[32] NPRM at ¶ 30.

¶ 30 of the NPRM could be appropriately modified to also address NGSO FSS systems using adaptive coding. More specifically, an in-line interference event between two NGSO FSS networks can be defined as the period of time during which (a) 10% of the time allowance for the BER specified in the short-term performance objectives of either network is exceeded; or (b) there is a 10% decrease in the amount of reserve capacity available to links that require heavier coding to compensate for rain fading in either network, as applicable.

Teledesic believes that such a general definition is all that should be included in the service rules. From this definition, each pair of operators would identify the relative geometric configurations of interfering and interfered-with links that lead to "in-line interference events." Such identification has been traditionally done by defining avoidance angles that, when not complied with, lead to the occurrence of in-line interference events. Appendix 1 provides a more detailed description of how the general definition of in-line interference events given above (10% of the time allowance associated with the short-term BER) can be converted into avoidance angles, based either at the earth station or at the satellite.

D. Consideration of Multiple Interference Sources

Teledesic addressed this matter in its response to the Commission's Ku-band NPRM and is of the view that, as in the Ku-band situation, the service rules applicable to Ka- band should include provisions to scale the aggregate interference allowance (10%) in order to account for multiple interference sources.

Studies currently under way in ITU-R have addressed the issue of apportioning the 10% interference allowance among the several interfering NGSO FSS systems. No concluding results have been published to date although the current status of the work has been

reported.[33] There is evidence that even for the small percentage of time associated with the short-term BER requirement, there is interference aggregation both in time and in power. In any case, it is always possible to express the single-entry requirement as a percentage of the time allowance for the BER specified in the short-term performance objectives (or as a percentage of the reserve capacity for systems employing adaptive coding). Tentatively and until ITU-R studies on the matter are concluded, Teledesic proposes a 7% allowance when three systems are involved (two interfering sources) and a 5% allowance when four or more systems are involved (three or more interfering sources).

This means that for the first two systems that become operational, in-line interference events are defined as described in Part II.C above, with the 10% allowance applying to the single-entry interference, which in this case coincides with the aggregate interference.

When a third system becomes operational, avoidance angles applicable to any pair of systems should be computed based on a 7% single-entry allowance. This means that avoidance angles that were being used to define in-line interference events between the first two operational systems would have to be recalculated, since the corresponding allowance for mutual interference was reduced from 10% to 7%. When a fourth or any subsequent system becomes operational, avoidance angles applicable to any pair of systems should be computed based on a 5% single-entry allowance. The 5% and 7% numbers, however, should be made expressly subject to revision based on further work within the ITU-R.

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[33] "Further Work Toward a Definition of a Single-Entry Interference Criterion to Be Used During Coordination Between Two Non-GSO FSS Systems," Document 4A/TEMP/92 (April 30, 2001).

E. Impact of Option III on System Design and Commercial Feasibility

The Commission seeks "comment on whether the complexity of managing multi-constellation in-line interference events through satellite switching protocols or frequency selection algorithms would negate the inherent benefits of [Option III]." Teledesic believes that this is not the case because, in general, most of the capabilities required to implement Option III are necessary anyway.

For example, the capability for earth stations to switch between satellites has to be incorporated in all NGSO FSS systems because hand-offs are inherent to systems using satellites in non-geostationary orbit. Similarly, because Ka-band NGSO FSS operators must coordinate both with U.S. government systems and with a number of non-U.S. systems, the capability of ceasing transmissions between satellites at given positions in space and specific points on Earth also needs to be incorporated in these NGSO FSS systems. The need for coordination with other NGSO FSS systems to avoid in-line interference events will increase the frequency of satellite hand-offs, and/or require ceasing transmission in portions of the operational bandwidth for short periods of time. However, this adds only marginally to system complexity because the capability to perform these operations, albeit less often, was already required.

Furthermore, the marginal cost of these features is easily exceeded by the benefit in terms of more intensive spectrum use. If n NGSO FSS systems are operational, the additional operational complexity brought about by having to switch to a different satellite, or cease transmission in certain frequency ranges, is a relatively small price to pay for access to a bandwidth B during most of the time (*i.e.*, all of the time except when in-line events occur) as opposed to having access to a bandwidth B/n during 100% of the time (the default arrangement

in Options I and II).[34] This would seem to be a good trade for such a significant increase in capacity.

If an NGSO FSS constellation is designed to use satellite switching, it is desirable that it provide at least double coverage to as many locations as possible during percentages of time that are as close as possible to 100%. This would minimize the likelihood that service to a certain area would have to be provided within a reduced frequency range during in-line events. However, even if this feature is not incorporated in the constellation design, it is certainly preferable to have this frequency range reduction for a small percentage of time than for 100% of the time.

III. FOR THE MOST PART, THE COMMISSION SHOULD DEFER ANY SUBSTANTIAL REVISIONS OF THE SERVICE RULES TO THE CONTEMPORANEOUS PROCEEDING ON LICENSING REFORM.

Finally, Teledesic comments on the few miscellaneous questions posed in the NPRM regarding gaps in the NGSO FSS service rules. In general, Teledesic urges the Commission to regulate second-round licensees in continuity with the service rules promulgated for first-round licensees. While there are ample reasons for thinking these rules can be improved, those matters are more appropriately considered in the Commission's pending rulemaking on satellite licensing reform.[35] Teledesic does, however, offer a brief word about each of the topics specifically raised by the Commission.

First, the Commission once again recounts its history with financial qualification tests and asks (a) whether a strict standard should be imposed; and (b) if so, what it should be. The

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[34] This reduction in bandwidth (capacity) does not apply to Option IV but, as discussed in Section I above, the use of homogeneous orbits has other severe shortcomings.

[35] *Amendment of the Commission's Space Station Licensing Rules and Policies*, Notice of Proposed Rulemaking, FCC 02-45, 2002 FCC LEXIS 1033, I.B. Docket No. 02-34/00-248 (rel. Feb. 28, 2002) (hereinafter "*Space Station Licensing NPRM*").

Commission makes a number of stimulating suggestions about what a revised financial standard might look like, and surely some of these are on the right track. In particular, it seems obvious that any evaluation of financial commitment should look only at "the commitment of funds not previously committed for any other purpose."[36] Otherwise, the Commission is essentially at the mercy of unlimited double-counting by applicants. On the other hand, the much more difficult question is what it means for funds to be "committed" in the first place. The "current asset" test used in the traditional test (the one the Commission now routinely waives) is also an exercise in double-counting, and it is a particularly pernicious one in light of the extent to which it disadvantages smaller, more entrepreneurial applicants. In addition, Teledesic has previously noted that the traditional test perversely favors wholly-owned subsidiaries of large parent companies over applicants with a broader and even better-funded ownership base. It is not at all unlikely that revision of the financial standards would prove outcome-determinative for some of the second-round NGSO FSS applicants. However, the questions that need to be raised regarding financial standards are not in any way peculiar to the Ka band. Accordingly, Teledesic believes the Commission should defer any substantial revision of the financial standard until the matter can be considered in the pending rulemaking on licensing reform.

Second, the Commission proposes two alternative sets of implementation milestones. One alternative tracks the milestones recently imposed on 2 GHz MSS licensees,[37] while the other proposes in very general terms to count backwards from each system's ITU "bring into use" date.[38] Naturally, some combination of these approaches is also possible. Again, the issues raised are for the most part not specific to the Ka band, and even more fundamental questions

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[36] NPRM at ¶ 39.

[37] *Id.* at ¶ 40.

[38] *Id.* at ¶ 41.

about implementation milestones are being asked in the NPRM on licensing reform.[39] In addition, Teledesic observes that the ITU date for bringing the second-round systems into use is now approaching so soon that milestones based on the 2 GHz MSS precedent would have little effect on the second-round licensees. Teledesic therefore suggests once again that any substantial revision in milestone policy be deferred to the proceeding on licensing reform. In the meantime, second-round licensees should be governed by the same milestones that were imposed on Teledesic, considering of course the different dates of the license grants.

The Commission proposes to modify section 25.145 to eliminate any obligation to report unscheduled outages in the licensee's annual report. Teledesic endorses this change. In addition, the Commission seeks comment on an @contact proposal to require quarterly reports on milestone compliance and an unattributed proposal to require NGSO FSS operators to certify milestone compliance by affidavit following the passage of each milestone. Teledesic opposes these proposals.

Quarterly milestone reporting might make sense if licensees had to meet quarterly milestones. But there are no quarterly milestones, which means that there is nothing, really, to report on a quarterly basis, and also that there is absolutely no reason for the Commission to "monitor" compliance because enforcement would not come until the next (non-quarterly) milestone date. The proposed requirement that milestone compliance be affirmatively certified is more sensible, and Teledesic certainly supports an across-the-board requirement that satisfaction of each milestone be affirmatively certified to the Commission, in place of the "no news is good news" approach that has governed in the past. However, the requirement of an affidavit, especially one "under penalty of perjury," is a useless formality. Licensees are bound

[39] *Space Station Licensing NPRM*, 2002 FCC LEXIS 1033 at ¶¶ 101-108.

by their duty of candor to the Commission, and individuals who knowingly make false statements to an agency of the federal government can be prosecuted under 18 U.S.C. §1001[40] regardless of whether they include the false statement in an affidavit signed "under penalty of perjury."[41]

The Commission proposes to require each NGSO FSS applicant to disclose its plans for orbital debris mitigation, and states that an upcoming rulemaking will be devoted to this topic.[42] Teledesic supports the interim rule requiring disclosure of orbital debris mitigation strategies, and looks forward to participating in that more general rulemaking.

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[40] The penalties for both a perjury conviction under 18 U.S.C. § 1621 and a false-statements conviction under 18 U.S.C. § 1001 are identical -- a fine plus up to five years in prison. In fact, the most significant difference between the two is that a perjury conviction is more difficult to obtain. It requires proof of the same elements as a false-statements conviction (willfulness, falsity, and materiality) plus proof that 1) the false statement occurred "under oath" and 2) that the F.C.C. was in fact authorized to administer the oath under the circumstances.

[41] As with financial standards and milestones, there are larger questions about the proposed reporting requirements that deserve to be considered in the context of the rulemaking on licensing reform. For example, if the Commission really intends to look at each and every satellite construction contract as a matter of form, as the January 2002 batch of compliance inquiries suggests, then there would seem to be no reason to require any certification at all for the contracting milestone – submission of the contract would be sufficient and more logical. In addition, the Commission must be more sensitive to the need for confidentiality. Under current practice, unscrupulous competitors can use frivolous regulatory challenges as a vehicle for collecting competitively sensitive information that would not otherwise be available to them. Sadly, as the Commission is aware, this possibility is not merely hypothetical. But again, these issues are not peculiar to the Ka band, and are well beyond the scope of what is proposed in the NPRM.

[42] NPRM at ¶ 43.

Finally, Teledesic supports the proposal regarding the terms of the system license to be granted.

Respectfully submitted,

By: Kelly S. McGinn

Mark A. Grannis
Kelly S. McGinn
Harris, Wiltshire & Grannis LLP
1200 Eighteenth Street, N.W.
Washington, D.C. 20036
(202) 730-1300

April 3, 2002

Attorneys for Teledesic LLC

APPENDIX 1
Use of Avoidance Angles and Recommendation ITU-R S.1323-1 to Define "In-Line" Events

1 Interference Mitigation Using Earth Station-Based and Satellite Station-Based Avoidance Angles

To assess interference between any two non-GSO FSS systems, it is necessary to examine four interference scenarios, derived from the combinations of link direction and which system is the victim system. For the purposes of this discussion, the four interference scenarios may be defined as follows:

Case 1: System-B interference into System-A uplink
Case 2: System-B interference into System-A downlink
Case 3: System-A interference into System-B uplink
Case 4: System-A interference into System-B downlink

Figure 1 shows these four interference scenarios. The angle θ_T represents the transmit discrimination angle (i.e., the angle off-boresight between the transmitter's signal path and the interference path), and the angle θ_R represents the receive discrimination angle.

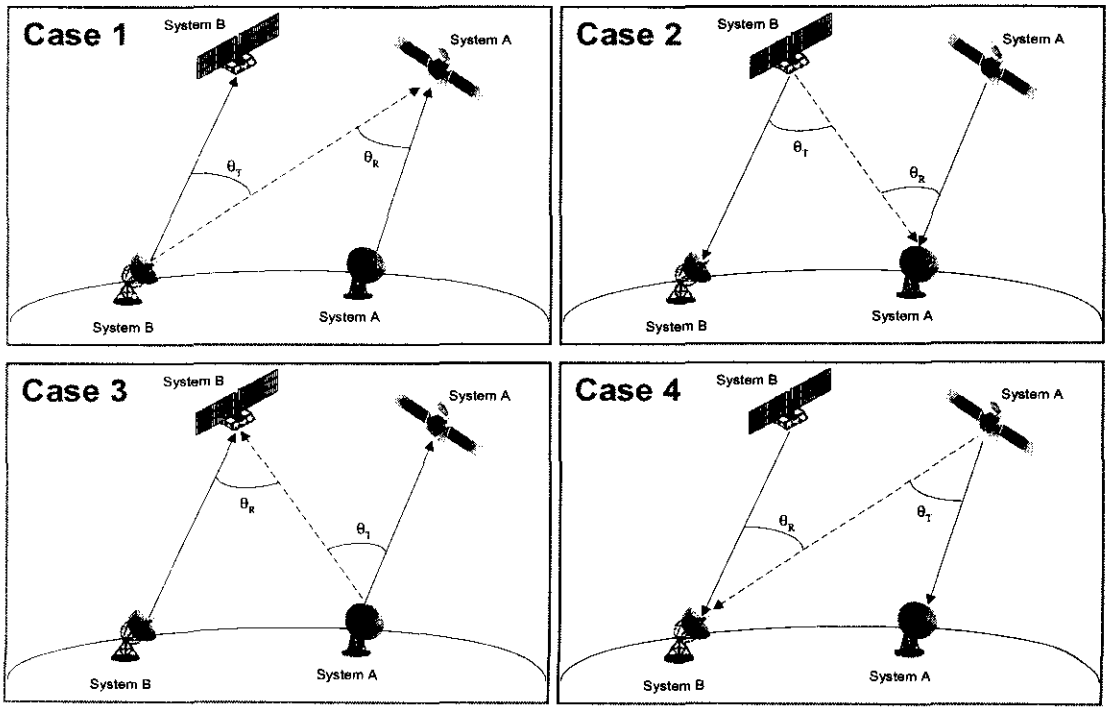

Figure 1 Four Interference Scenarios

For each of the four cases, it is possible to calculate a minimum angular separation between the desired links and the interfering links, which if maintained at all times, would reduce the interference to the levels characterized as permissible in Recommendation ITU-R S.1323-1. This minimum angular separation, hereafter called the avoidance angle, is likely to be different for each of the four cases. Therefore, after all interference scenarios are considered, four avoidance angles result.

Where the two non-GSO systems under consideration are of approximately the same altitude, it is possible to achieve all necessary interference mitigation by setting an avoidance angle α that is defined at the earth station of the system that is implementing avoidance. The angle α will be the largest of the four avoidance angles associated with the four interference scenarios. This is illustrated in Figure 2. The same is true for systems with a large difference between orbit altitudes (e.g., a LEO and a MEO) but only when the lower-altitude system (LEO) is the one implementing the avoidance.

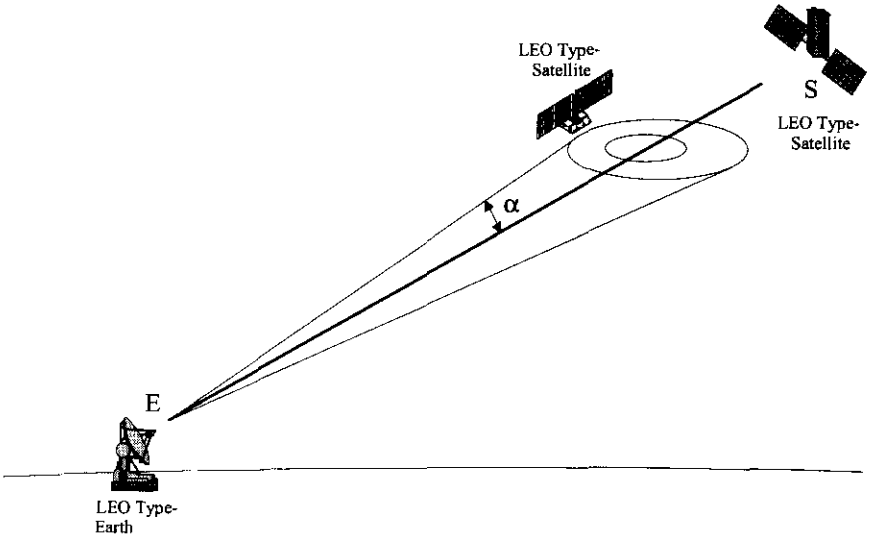

Figure 2 Avoidance Angle α Defined at the Earth Station

However, when there is a large difference between the altitudes of the two non-GSO systems and avoidance is being implemented by the system with the higher orbit altitude, the burden of employing avoidance angles will be minimized if the mitigating system uses both an earth station-based avoidance angle and a satellite station-based avoidance angle. Let System A be a LEO and System B be a MEO. Assume that System B is implementing avoidance. Thus, for the protection of the System A uplink (case 1) and of the System B downlink (case 4), earth station-based angles are defined. For the protection of the System A downlink (case 2) and the System B uplink (case 3), satellite station-based angles are defined. The combination of the largest of the two earth station-based angles (α) with the largest of the two satellite station-based angles (β) defines the requirements to ensure protection of both systems. This is illustrated in Figure 3.

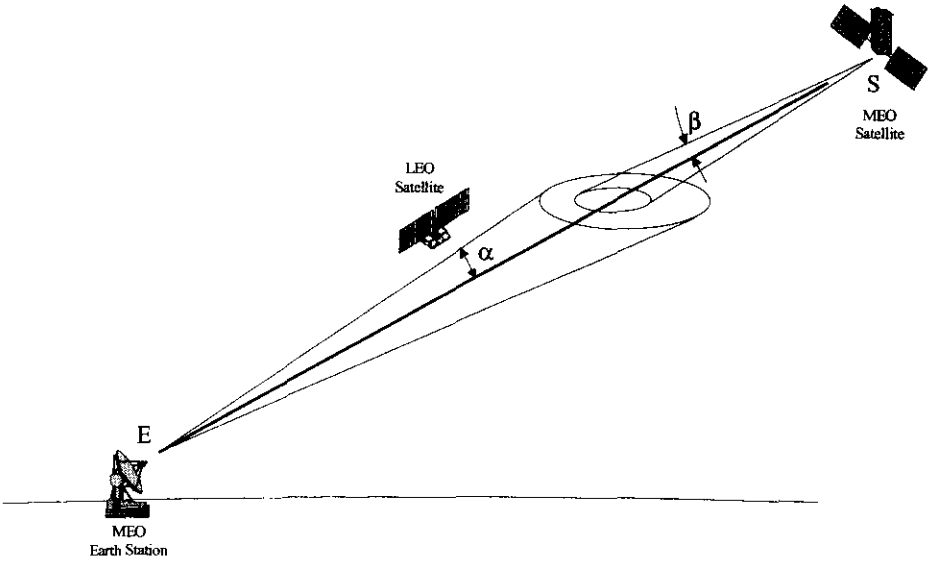

Figure 3 Illustration of Avoidance Angles α and β

For System B to implement the avoidance angles illustrated in Figure 3, System B would establish a two-way connection between a System B earth station **E** and System B satellite **S** if two conditions are met:

(i) there is no System A satellite within a cone with axis **ES** and characterized by an angle α, as seen from the System B earth station;

(ii) there is no System A satellite within a cone with axis **SE** and characterized by an angle β, as seen from the System B satellite.

2 Using Recommendation ITU-R S.1323-1 to Derive Avoidance Angles

When used to evaluate whether or not the interference resulting from the implementation of a given avoidance angle is acceptable, the methodology set forth in Recommendation ITU-R S.1323-1 is relatively straightforward, providing a simple 'pass' or 'fail' evaluation for that interference case. Deriving the required avoidance angle then essentially involves iterating the avoidance angle used in the interference collection process until a passing result is achieved in the evaluation step.

The use of this methodology to verify a given scenario's compliance with Recommendation ITU-R S.1323-1 involves the following steps:

1) Determine the degradation threshold value, D_{th}, at which a link outage occurs.

2) From link parameters (i.e., clear-sky and heavy-rain link budgets including allocations for rain fading and total link margins) and rain fading modeling data, establish a rain degradation (X) probability density function (pdf).

3) Generate an interference degradation (Y) pdf from the I/N values collected from a simulation or other analytical approach providing probabilities associated with each I/N value. The relationship between interference degradation and I/N is simply:

$$Y = I + I/N$$

where all values are in factor (not dB) form.

4) Convolve the rain and interference degradation pdf's to generate a total degradation (Z) pdf.

5) Determine the acceptable percentage of the total degradation exceeding D_{th}, from the probability of rain degradation exceeding that value and the allowed percentage of total degradation due to interference (10% assumed here):

$$P_{threshold} = P(X \geq D_{th}) / (1 - 0.1)$$

6) A 'pass' or 'fail' evaluation is assigned to this case, based on the truth of the following relationship:

$$P(Z \geq D_{th}) \leq P_{threshold}$$

3 Using Avoidance Angles to Define "In-Line Events"

Based on the above analysis, it is possible to define avoidance angle(s) α (and β when required), for System B relative to System A, such that if implemented by System B, the resulting mutual interference between the two systems is reduced to levels characterized as permissible in Recommendation ITU-R S.1323-1. For System B, then, an "in-line event" relative to System A occurs whenever:

(a) a System A satellite is within a cone with axis **ES** and characterized by an angle α, as seen from a System B earth station;

and when required,

(b) a System A satellite is within a cone with axis SE and characterized by an angle β, as seen from the System B satellite,

where α and β are defined in Figure 3 above.